

# TLP152

## 1. Applications

- Plasma Display Panels (PDPs)
- Industrial Inverters
- MOSFET Gate Drivers
- IGBT Gate Drivers

## 2. General

The TLP152 is a photocoupler in an SO6 package that consists of a GaAlAs infrared light-emitting diode (LED) optically coupled to an integrated high-gain, high-speed photodetector IC chip. The photodetector IC chip has an internal shield to provide a high common-mode transient immunity of  $\pm 20 \text{ kV}/\mu\text{s}$  and thus superior noise immunity between the input and output pins. The TLP152 has a totem-pole output that can both sink and source current. It is suitable for directly driving a small IGBT or power MOSFET.

## 3. Features

- (1) Buffer logic type (totem pole output)
- (2) Output peak current:  $\pm 2.5 \text{ A}$  (max)
- (3) Operating temperature:  $-40$  to  $100^\circ\text{C}$
- (4) Supply current:  $3.0 \text{ mA}$  (max)
- (5) Supply voltage:  $10$  to  $30 \text{ V}$
- (6) Threshold input current:  $7.5 \text{ mA}$  (max)
- (7) Propagation delay time:  $t_{\text{pHL}} = 190 \text{ ns}$  (max),  $t_{\text{pLH}} = 170 \text{ ns}$  (max)
- (8) Common-mode transient immunity:  $\pm 20 \text{ kV}/\mu\text{s}$  (min)
- (9) Isolation voltage:  $3750 \text{ Vrms}$  (min)
- (10) Safety standards

UL-approved: UL1577, File No.E67349

cUL-approved: CSA Component Acceptance Service No.5A File No.E67349

VDE-approved: EN60747-5-5, EN60065 or EN60950-1 (**Note 1**)

: EN62368-1 (Pending) (**Note 1**)

CQC-approved: GB4943.1, GB8898 Thailand Factory



仅适用于海拔 2000m 以下地区安全使用

Note 1: When a VDE approved type is needed, please designate the **Option (V4)**.

Start of commercial production

2012-06



## 7. Absolute Maximum Ratings (Note) (Unless otherwise specified, $T_a = 25\text{ }^{\circ}\text{C}$ )

|          | Characteristics                                                                      | Symbol                  | Note     | Rating     | Unit                   |
|----------|--------------------------------------------------------------------------------------|-------------------------|----------|------------|------------------------|
| LED      | Input forward current                                                                | $I_F$                   |          | 20         | mA                     |
|          | Peak transient input forward current                                                 | $I_{FPT}$               | (Note 1) | 1          | A                      |
|          | Input reverse voltage                                                                | $V_R$                   |          | 5          | V                      |
|          | Input power dissipation                                                              | $P_D$                   |          | 40         | mW                     |
| Detector | Peak high-level output current ( $T_a = -40\text{ to }100\text{ }^{\circ}\text{C}$ ) | $I_{OPH}$               | (Note 2) | -2.5       | A                      |
|          | Peak low-level output current ( $T_a = -40\text{ to }100\text{ }^{\circ}\text{C}$ )  | $I_{OPL}$               | (Note 2) | +2.5       |                        |
|          | Output voltage                                                                       | $V_O$                   |          | 35         | V                      |
|          | Supply voltage                                                                       | $V_{CC}$                |          | 35         |                        |
|          | Output power dissipation                                                             | $P_O$                   |          | 260        | mW                     |
|          | Output power dissipation derating ( $T_a \geq 85\text{ }^{\circ}\text{C}$ )          | $\Delta P_O/\Delta T_a$ |          | -2.0       | mW/ $^{\circ}\text{C}$ |
| Common   | Operating temperature                                                                | $T_{opr}$               |          | -40 to 100 | $^{\circ}\text{C}$     |
|          | Storage temperature                                                                  | $T_{stg}$               |          | -55 to 125 |                        |
|          | Lead soldering temperature (10 s)                                                    | $T_{sol}$               | (Note 3) | 260        |                        |
|          | Isolation voltage (AC, 60 s, R.H. $\leq 60\%$ )                                      | $BV_S$                  | (Note 4) | 3750       | Vrms                   |

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc.).

Note 1: Pulse width (PW)  $\leq 1\text{ }\mu\text{s}$ , 300 pps

Note 2: Exponential waveform. Pulse width  $\leq 0.2\text{ }\mu\text{s}$ ,  $f \leq 15\text{ kHz}$ ,  $V_{CC} = 20\text{ V}$ ,  $T_a = -40\text{ to }100\text{ }^{\circ}\text{C}$   
Exponential waveform. Pulse width  $\leq 0.08\text{ }\mu\text{s}$ ,  $f \leq 25\text{ kHz}$ ,  $V_{CC} = 15\text{ V}$ ,  $T_a = -40\text{ to }100\text{ }^{\circ}\text{C}$

Note 3:  $\geq 2\text{ mm}$  below seating plane.

Note 4: This device is considered as a two-terminal device: Pins 1 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

## 8. Recommended Operating Conditions (Note)

| Characteristics                | Symbol       | Note     | Min | Typ. | Max  | Unit |
|--------------------------------|--------------|----------|-----|------|------|------|
| Input on-state current         | $I_{F(ON)}$  | (Note 1) | 10  | —    | 15   | mA   |
| Input off-state voltage        | $V_{F(OFF)}$ |          | 0   | —    | 0.8  | V    |
| Peak high-level output current | $I_{OPH}$    |          | —   | —    | -2.0 | A    |
| Peak low-level output current  | $I_{OPL}$    |          | —   | —    | +2.0 |      |
| Operating frequency            | $f$          | (Note 2) | —   | —    | 250  | kHz  |

Note: The recommended operating conditions are given as a design guide necessary to obtain the intended performance of the device. Each parameter is an independent value. When creating a system design using this device, the electrical characteristics specified in this data sheet should also be considered.

Note: A ceramic capacitor (0.1  $\mu\text{F}$ ) should be connected between pin 6 and pin 4 to stabilize the operation of a high-gain linear amplifier. Otherwise, this photocoupler may not switch properly. The bypass capacitor should be placed within 1 cm of each pin.

Note 1: The rise and fall times of the input on-current should be less than 0.5  $\mu\text{s}$ .

Note 2: Exponential waveform.  $I_{OPH} \geq -0.65\text{ A}$  ( $\leq 80\text{ ns}$ ),  $I_{OPL} \leq 0.65\text{ A}$  ( $\leq 80\text{ ns}$ ),  $T_a = 100\text{ }^{\circ}\text{C}$ ,  $V_{CC} = 20\text{ V}$

## 9. Electrical Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $100\text{ }^{\circ}\text{C}$ )

| Characteristics                               | Symbol                    | Note     | Test Circuit | Test Condition                                                              | Min  | Typ. | Max  | Unit                   |
|-----------------------------------------------|---------------------------|----------|--------------|-----------------------------------------------------------------------------|------|------|------|------------------------|
| Input forward voltage                         | $V_F$                     |          | —            | $I_F = 10\text{ mA}$ , $T_a = 25\text{ }^{\circ}\text{C}$                   | 1.40 | 1.57 | 1.80 | V                      |
| Input forward voltage temperature coefficient | $\Delta V_F / \Delta T_a$ |          | —            | $I_F = 10\text{ mA}$                                                        | —    | -1.8 | —    | mV/ $^{\circ}\text{C}$ |
| Input reverse current                         | $I_R$                     |          | —            | $V_R = 5\text{ V}$ , $T_a = 25\text{ }^{\circ}\text{C}$                     | —    | —    | 10   | $\mu\text{A}$          |
| Input capacitance                             | $C_t$                     |          | —            | $V = 0\text{ V}$ , $f = 1\text{ MHz}$ , $T_a = 25\text{ }^{\circ}\text{C}$  | —    | 45   | —    | pF                     |
| Peak high-level output current                | $I_{OPH}$                 | (Note 1) | Fig. 12.1.1  | $I_F = 10\text{ mA}$ , $V_{CC} = 15\text{ V}$ , $V_{6-5} = 4\text{ V}$      | —    | -2.2 | -1.0 | A                      |
|                                               |                           |          |              | $I_F = 10\text{ mA}$ , $V_{CC} = 15\text{ V}$ , $V_{6-5} = 10\text{ V}$     | —    | -3.4 | -2.0 |                        |
| Peak low-level output current                 | $I_{OPL}$                 | (Note 1) | Fig. 12.1.2  | $I_F = 0\text{ mA}$ , $V_{CC} = 15\text{ V}$ , $V_{5-4} = 2\text{ V}$       | 1.0  | 2.4  | —    | A                      |
|                                               |                           |          |              | $I_F = 0\text{ mA}$ , $V_{CC} = 15\text{ V}$ , $V_{5-4} = 10\text{ V}$      | 2.0  | 3.5  | —    |                        |
| High-level output voltage                     | $V_{OH}$                  |          | Fig. 12.1.3  | $I_F = 10\text{ mA}$ , $V_{CC} = 10\text{ V}$ , $I_O = -100\text{ mA}$      | 6.0  | 8.5  | —    | V                      |
| Low-level output voltage                      | $V_{OL}$                  |          | Fig. 12.1.4  | $V_F = 0.8\text{ V}$ , $V_{CC} = 10\text{ V}$ , $I_O = 100\text{ mA}$       | —    | 0.1  | 1.0  |                        |
| High-level supply current                     | $I_{CCH}$                 |          | Fig. 12.1.5  | $I_F = 10\text{ mA}$ , $V_{CC} = 10$ to $30\text{ V}$ , $V_O = \text{Open}$ | —    | 1.9  | 3.0  | mA                     |
| Low-level supply current                      | $I_{CCL}$                 |          | Fig. 12.1.6  | $I_F = 0\text{ mA}$ , $V_{CC} = 10$ to $30\text{ V}$ , $V_O = \text{Open}$  | —    | 1.8  | 3.0  |                        |
| Threshold input current (L/H)                 | $I_{FLH}$                 |          | —            | $V_{CC} = 15\text{ V}$ , $V_O > 1\text{ V}$                                 | —    | 1.5  | 7.5  | V                      |
| Threshold input voltage (H/L)                 | $V_{FHL}$                 |          | —            | $V_{CC} = 15\text{ V}$ , $V_O < 1\text{ V}$                                 | 0.8  | 1.47 | —    |                        |
| Supply voltage                                | $V_{CC}$                  |          | —            | —                                                                           | 10   | —    | 30   |                        |
| UVLO threshold voltage                        | $V_{UVLO+}$               |          | —            | $I_F = 5\text{ mA}$ , $V_O > 2.5\text{ V}$                                  | 7.8  | 8.7  | 9.7  |                        |
|                                               | $V_{UVLO-}$               |          | —            | $I_F = 5\text{ mA}$ , $V_O < 2.5\text{ V}$                                  | 7.5  | 8.4  | 9.4  |                        |
| UVLO hysteresis                               | $UVLO_{HYS}$              |          | —            | $I_F = 5\text{ mA}$ , $V_O > 2.5\text{ V}$                                  | —    | 0.3  | —    |                        |

Note: All typical values are at  $T_a = 25\text{ }^{\circ}\text{C}$ .

Note: This device is designed for low power consumption, making it more sensitive to ESD than its predecessors. Extra care should be taken in the design of circuitry and pc board implementation to avoid ESD problems.

Note 1:  $I_O$  application time  $\leq 50\text{ }\mu\text{s}$ , single pulse.

## 10. Isolation Characteristics (Unless otherwise specified, $T_a = 25\text{ }^{\circ}\text{C}$ )

| Characteristics                     | Symbol | Note     | Test Conditions                         | Min                | Typ.      | Max | Unit      |
|-------------------------------------|--------|----------|-----------------------------------------|--------------------|-----------|-----|-----------|
| Total capacitance (input to output) | $C_S$  | (Note 1) | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$ | —                  | 0.35      | —   | pF        |
| Isolation resistance                | $R_S$  | (Note 1) | $V_S = 500\text{ V}$ , R.H. $\leq 60\%$ | $1 \times 10^{12}$ | $10^{14}$ | —   | $\Omega$  |
| Isolation voltage                   | $BV_S$ | (Note 1) | AC, 60 s                                | 3750               | —         | —   | $V_{rms}$ |
|                                     |        |          | AC, 1 s in oil                          | —                  | 10000     | —   |           |
|                                     |        |          | DC, 60 s in oil                         | —                  | 10000     | —   | Vdc       |

Note 1: This device is considered as a two-terminal device: Pins 1 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

## 11. Switching Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $100\text{ }^{\circ}\text{C}$ )

| Characteristics                               | Symbol                | Note                 | Test Circuit | Test Condition                                                                                                                                     | Min      | Typ. | Max | Unit              |
|-----------------------------------------------|-----------------------|----------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------|----------|------|-----|-------------------|
| Propagation delay time (L/H)                  | $t_{pLH}$             | (Note 1)             | Fig. 12.1.7  | $I_F = 0 \rightarrow 10\text{ mA}$ , $V_{CC} = 30\text{ V}$ , $R_g = 20\text{ }\Omega$ , $C_g = 10\text{ nF}$ , $T_a = 25\text{ }^{\circ}\text{C}$ | 60       | 95   | 145 | ns                |
| Propagation delay time (H/L)                  | $t_{pHL}$             | (Note 1)             |              | $I_F = 10 \rightarrow 0\text{ mA}$ , $V_{CC} = 30\text{ V}$ , $R_g = 20\text{ }\Omega$ , $C_g = 10\text{ nF}$ , $T_a = 25\text{ }^{\circ}\text{C}$ | 60       | 110  | 165 |                   |
| Propagation delay time (L/H)                  | $t_{pLH}$             | (Note 1)             |              | $I_F = 0 \rightarrow 10\text{ mA}$ , $V_{CC} = 30\text{ V}$ , $R_g = 20\text{ }\Omega$ , $C_g = 10\text{ nF}$                                      | 50       | 95   | 170 |                   |
| Propagation delay time (H/L)                  | $t_{pHL}$             | (Note 1)             |              | $I_F = 10 \rightarrow 0\text{ mA}$ , $V_{CC} = 30\text{ V}$ , $R_g = 20\text{ }\Omega$ , $C_g = 10\text{ nF}$                                      | 50       | 110  | 190 |                   |
| Propagation delay skew (device to device)     | $t_{psk}$             | (Note 1)<br>(Note 4) |              | $I_F = 0 \leftrightarrow 10\text{ mA}$ , $V_{CC} = 30\text{ V}$ , $R_g = 20\text{ }\Omega$ , $C_g = 10\text{ nF}$                                  | -85      | —    | 85  |                   |
| Pulse width distortion                        | $ t_{pHL} - t_{pLH} $ | (Note 1)             |              | $I_F = 0 \leftrightarrow 10\text{ mA}$ , $V_{CC} = 30\text{ V}$ , $R_g = 20\text{ }\Omega$ , $C_g = 10\text{ nF}$                                  | —        | 15   | 50  |                   |
| Rise time                                     | $t_r$                 | (Note 1)             |              | $I_F = 0 \rightarrow 10\text{ mA}$ , $V_{CC} = 30\text{ V}$ , $R_g = 20\text{ }\Omega$ , $C_g = 10\text{ nF}$                                      | —        | 18   | —   |                   |
| Fall time                                     | $t_f$                 | (Note 1)             |              | $I_F = 10 \rightarrow 0\text{ mA}$ , $V_{CC} = 30\text{ V}$ , $R_g = 20\text{ }\Omega$ , $C_g = 10\text{ nF}$                                      | —        | 22   | —   |                   |
| Common-mode transient immunity at output high | $CM_H$                | (Note 2)             | Fig. 12.1.8  | $V_{CM} = 1000\text{ V}_{p-p}$ , $I_F = 10\text{ mA}$ , $V_{CC} = 30\text{ V}$ , $T_a = 25\text{ }^{\circ}\text{C}$ , $V_{O(min)} = 26\text{ V}$   | $\pm 20$ | —    | —   | kV/ $\mu\text{s}$ |
| Common-mode transient immunity at output low  | $CM_L$                | (Note 3)             |              | $V_{CM} = 1000\text{ V}_{p-p}$ , $I_F = 0\text{ mA}$ , $V_{CC} = 30\text{ V}$ , $T_a = 25\text{ }^{\circ}\text{C}$ , $V_{O(max)} = 1\text{ V}$     | $\pm 20$ | —    | —   |                   |

Note: All typical values are at  $T_a = 25\text{ }^{\circ}\text{C}$ .

Note 1: Input signal ( $f = 125\text{ kHz}$ , duty = 50 %,  $t_r = t_f = 5\text{ ns}$  or less).

CL is approximately 15 pF which includes probe and stray wiring capacitance.

Note 2:  $CM_H$  is the maximum rate of fall of the common mode voltage that can be sustained with the output voltage in the logic high state ( $V_O > 26\text{ V}$ ).

Note 3:  $CM_L$  is the maximum rate of rise of the common mode voltage that can be sustained with the output voltage in the logic low state ( $V_O < 1\text{ V}$ ).

Note 4: The propagation delay skew,  $t_{psk}$ , is equal to the magnitude of the worst-case difference in  $t_{pHL}$  and/or  $t_{pLH}$  that will be seen between units at the same given conditions (supply voltage, input current, temperature, etc).

## 12. Test Circuits and Characteristics Curves

### 12.1. Test Circuits

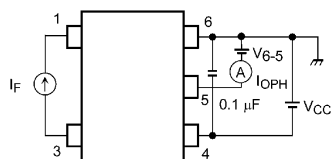


Fig. 12.1.1  $I_{OPH}$  Test Circuit

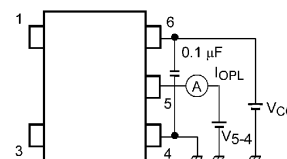


Fig. 12.1.2  $I_{OPL}$  Test Circuit

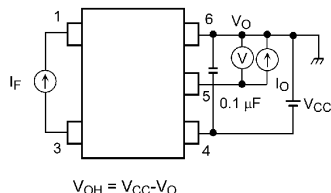


Fig. 12.1.3  $V_{OH}$  Test Circuit

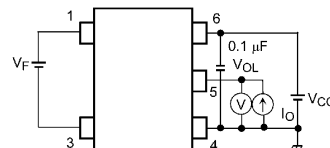


Fig. 12.1.4  $V_{OL}$  Test Circuit

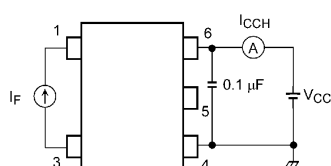


Fig. 12.1.5  $I_{CCH}$  Test Circuit

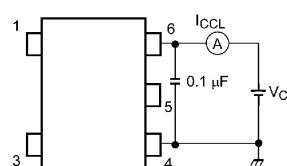
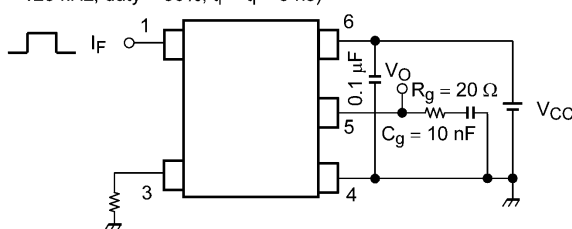


Fig. 12.1.6  $I_{CCL}$  Test Circuit

$I_F = 10 \text{ mA (P.G.)}$

$(f = 125 \text{ kHz, duty} = 50\%, t_r = t_f = 5 \text{ ns})$



P.G.: Pulse generator

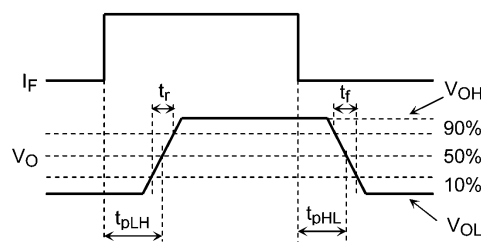
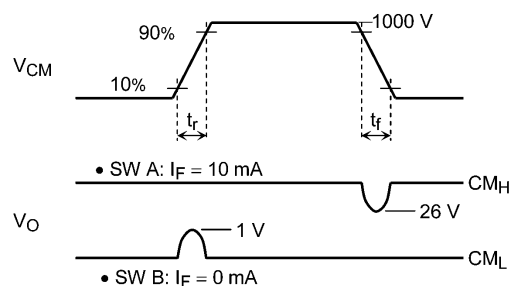
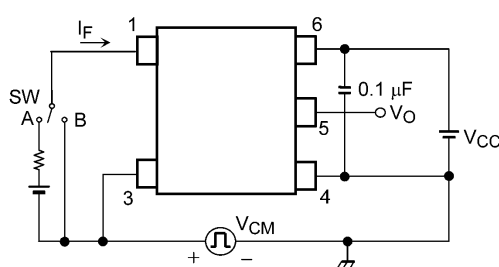


Fig. 12.1.7 Switching Time Test Circuit and Waveform



$$CM_L = \frac{800 \text{ V}}{t_r (\mu\text{s})} \quad CM_H = -\frac{800 \text{ V}}{t_f (\mu\text{s})}$$

Fig. 12.1.8 Common-Mode Transient Immunity Test Circuit and Waveform

## 13. Soldering and Storage

### 13.1. Precautions for Soldering

The soldering temperature should be controlled as closely as possible to the conditions shown below, irrespective of whether a soldering iron or a reflow soldering method is used.

- When using soldering reflow.

The soldering temperature profile is based on the package surface temperature.

(See the figure shown below, which is based on the package surface temperature.)

Reflow soldering must be performed once or twice.

The mounting should be completed with the interval from the first to the last mountings being 2 weeks.

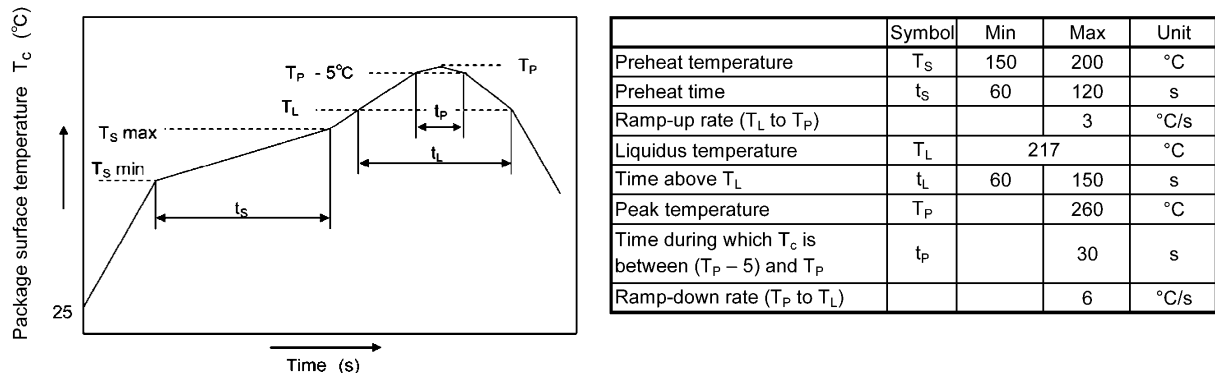


Fig. 13.1.1 An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used

- When using soldering flow

Preheat the device at a temperature of 150 °C (package surface temperature) for 60 to 120 seconds.

Mounting condition of 260 °C within 10 seconds is recommended.

Flow soldering must be performed once.

- When using soldering Iron

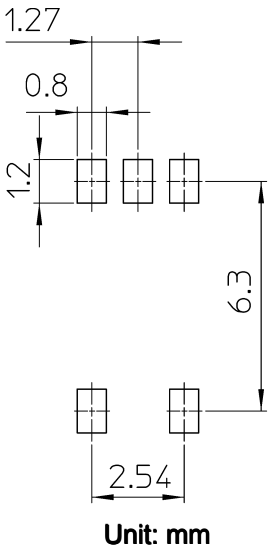
Complete soldering within 10 seconds for lead temperature not exceeding 260 °C or within 3 seconds not exceeding 350 °C

Heating by soldering iron must be done only once per lead.

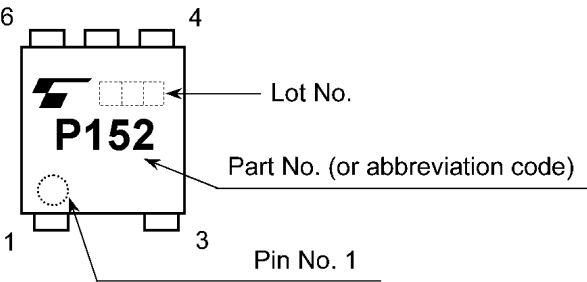
### 13.2. Precautions for General Storage

- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45 % to 75 %, respectively.
- Do not store the products in locations with poisonous gases (especially corrosive gases) or in dusty conditions.
- Store the products in locations with minimal temperature fluctuations. Rapid temperature changes during storage can cause condensation, resulting in lead oxidation or corrosion, which will deteriorate the solderability of the leads.
- When restoring devices after removal from their packing, use anti-static containers.
- Do not allow loads to be applied directly to devices while they are in storage.
- If devices have been stored for more than two years under normal storage conditions, it is recommended that you check the leads for ease of soldering prior to use.

14. Land Pattern Dimensions (for reference only)



15. Marking





## 16. Specifications for Embossed-Tape Packing

### 16.1. Applicable Package

| Package Name | Product Type      |
|--------------|-------------------|
| SO6          | Mini flat coupler |

### 16.2. Product Naming Conventions

Type of package used for shipment is denoted by a symbol suffix after a part number. The method of classification is as below.

Example) TLP152(TPL,E(T

Part number: TLP152

Tape type: TPL

[[G]]/RoHS COMPATIBLE: E (Note 1)

Domestic ID (Country/Region of origin: Thailand): T

Note 1: Please contact your Toshiba sales representative for details on environmental information such as the product's RoHS compatibility.

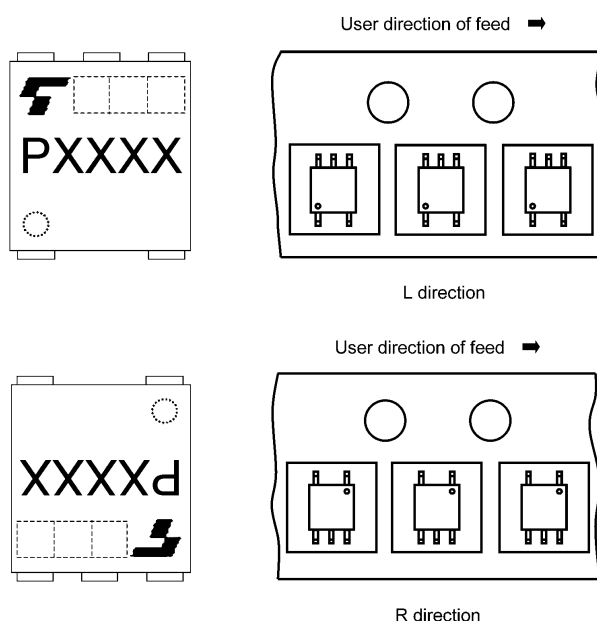
RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

### 16.3. Tape Dimensions Specification

| Tape Type | Division    | Packing Amount<br>(A unit per reel) |
|-----------|-------------|-------------------------------------|
| TPL       | L direction | 3000                                |
| TPR       | R direction | 3000                                |

#### 16.3.1. Orientation of Device in Relation to Direction of Feed

Device orientation in the carrier cavities as shown in the following figure.



Device Orientation



## 16.3.5. Reel Specification

Material: Plastic (for protection against static electricity)

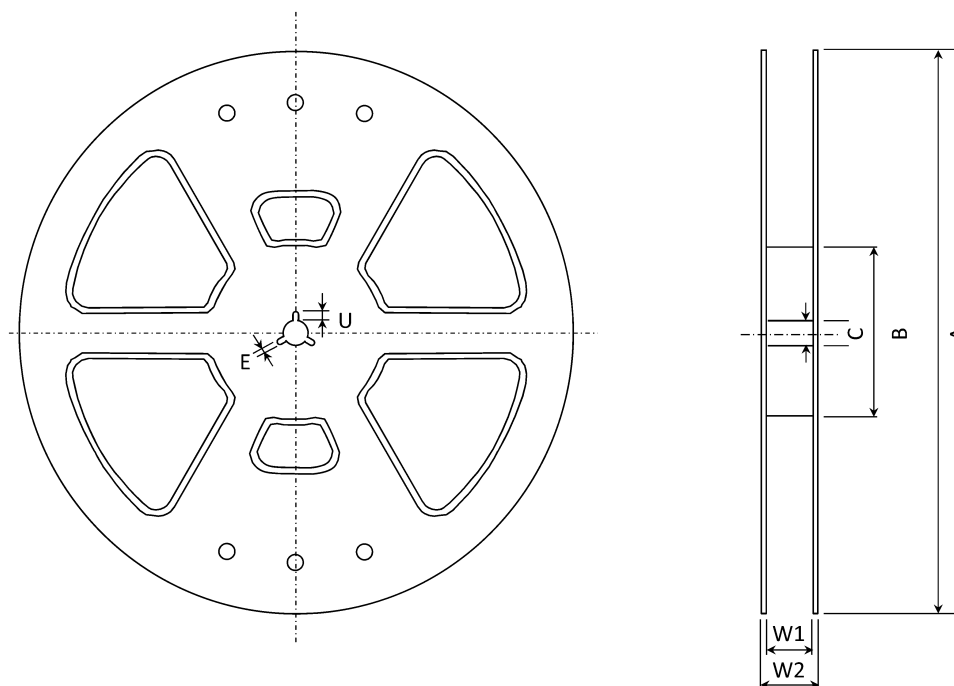
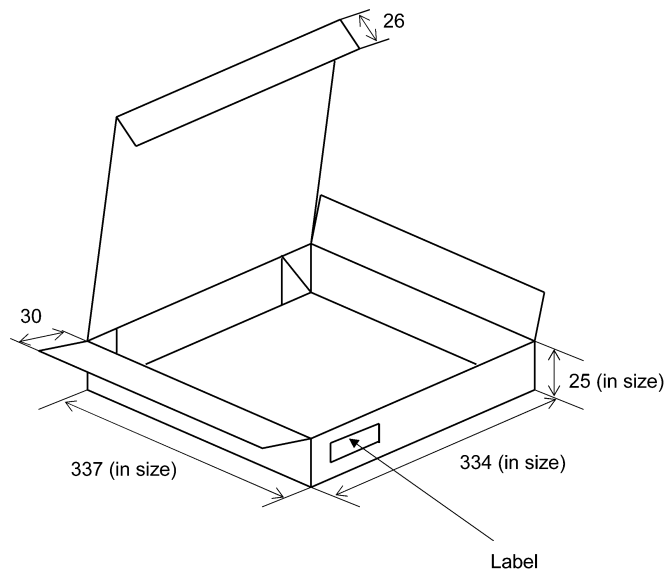


Table Reel Dimensions (unit: mm)

| Symbol | Dimension          |
|--------|--------------------|
| A      | $\phi 330 \pm 2.0$ |
| B      | $\phi 80 \pm 1.0$  |
| C      | $\phi 13 \pm 0.5$  |
| E      | $2.0 \pm 0.5$      |
| U      | $4.0 \pm 0.5$      |
| W1     | $13.5 \pm 0.5$     |
| W2     | $17.5 \pm 1.0$     |

## 16.3.6. Packing (Note)



1 reel/carton (unit: mm)

Note: Taping reel diameter:  $\phi 330$  mm

## 16.3.7. Label Format

- (1) Carton: The label provides the part number, quantity, lot number, the Toshiba logo, etc.
- (2) Reel: The label provides the part number, the taping name, quantity, lot number, etc.

## 16.4. Ordering Information

When placing an order, please specify the part number, tape type and quantity as shown in the following example.

Example) TLP152(TPL,E/T 3000 pcs

Part number: TLP152

Tape type: TPL (8-mm pitch)

[[G]]/RoHS COMPATIBLE: E (**Note 1**)

Domestic ID (Country/Region of origin: Thailand): T

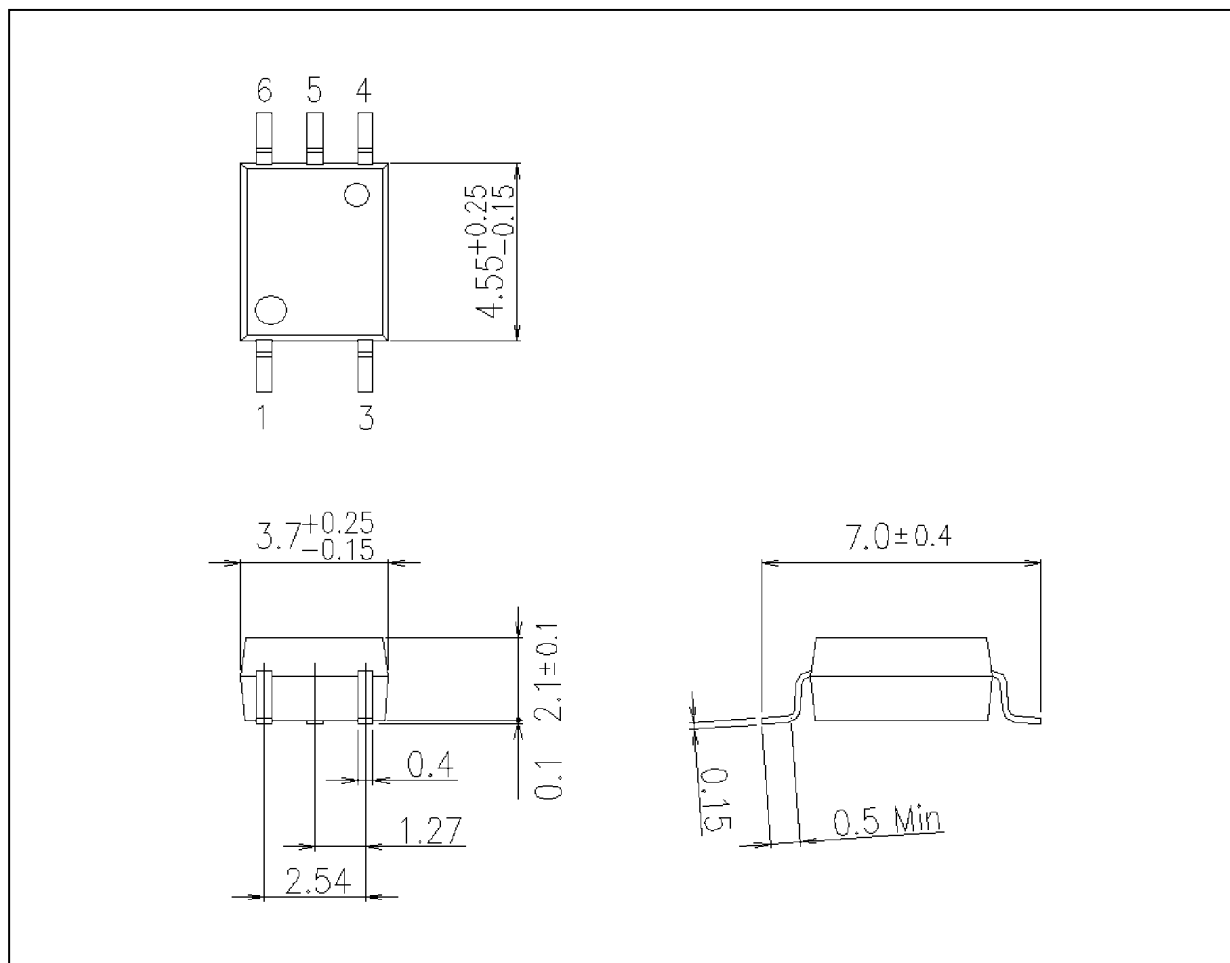
Quantity (must be a multiple of 3000): 3000 pcs

Note 1: Please contact your Toshiba sales representative for details on environmental information such as the product's RoHS compatibility.

RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

## Package Dimensions

Unit: mm



Weight: 0.08 g (typ.)

| Package Name(s)  |
|------------------|
| TOSHIBA: 11-4L1S |

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